

**Abstract**

Systems and methods convey the blood through a gap defined between an inner surface that is located about an axis and an outer surface that is concentric with the inner surface. At least one of the inner and outer surfaces carries a membrane that consists essentially of either a hemofiltration membrane or a hemodialysis membrane. The systems and methods cause relative movement between the inner and outer surfaces about the axis at a selected surface velocity, taking into account the size of the gap. The relative movement of the two surfaces creates movement of the blood within the gap, which creates vortical flow conditions that induce transport of cellular blood components from the membrane while plasma water and waste material are transported to the membrane for transport across the membrane. Shear-enhanced transport of waste materials and blood plasma water results.